be greater than in cold ones. An extreme case is that in which the temperature is so high as to produce general dissociation of the electrons from the nuclei, as appears to occur in the interior of stars. Apart from the disturbance produced by collisions, the magnetons are then free to set their axes parallel to the axis of rotation, and a large proportion of them would seem to do this in certain cases (*vide infra*). The upper limit of magnetisation is reached when all the magnetons are set parallel to the axis; this limit can be calculated in some cases, it being possible to estimate the number of electrons in electrostatically neutral matter of given kind and density. Other things being equal, the maximum magnetisation will be proportional to the density and independent of the speed of rotation.

The magnetic fields of the earth and sun can thus be accounted for on the present theory because these bodies are at a high temperature (in the case of the earth this is so except for the parts near the surface); what has hitherto been an obstacle in framing theories of their magnetic fields is here regarded as probably the determining factor as regards magnitude.

The same explanation applies to sun-spots. These occur in pairs of opposite magnetic polarity, and it has been pointed out that the polarities are such as would be accounted for by negative electricity in rotatory motion such as is observed (with opposite directions) in the members of a sun-spot pair. The sun-spot pair is thus regarded as the surface portion of a "line"-vortex continuously connecting the ends beneath the surface. The difficulty has been that no Stark effect is observable, such as would accompany rotating charges of the required amount; it has therefore been suggested that the magnetism of sun-spots is due to galvanic currents, *i.e.* electrons in translatory motion through electrostatically neutral matter. This hypothesis is unnecessary; it seems possible to account for the observed fields, of order 3000 gauss, simply by the observed rotation of the matter composing the vortex, on the above magneton hypothesis.

The obliquity of the magnetic axes of the earth and sun requires some additional hypothesis for its explanation, since an unsymmetrical condition cannot be accounted for by a cause, like rotation, symmetrical about an axis. The obliquity being present, however, it seems possible to explain the secular variations of the solar and terrestrial magnetic fields as due to precessional motion of the magnetons. A magnetic field applied obliquely to a magneton will tend to cause it to precess round the lines of external magnetic force. The magnetic fields of the earth and sun, due mainly to rotation, will exert this effect on any magnetons the axes of which are inclined to them; the speed of precession depends solely on the strength of the applied field if the magnetons are free, and the direction of precession agrees with the direction of rotation of the magnetic axes of the earth and sun.

S. CHAPMAN.

The University, Manchester, November 13.

Physiological Effects of Alcohol.

DURING recent years a good deal of work has been done and a great many results have been published on the above subject. Some of these have been very recently reported in the general Press. In most, if not in all, of the researches which have been made on the physiological effects of moderate doses of alcohol, taken in the form of beer, spirits, or other alcoholic beverages, but little attention has been paid to the very important disturbing influence of what may be called "secondary products"—whether extractive matters normal to the beverages in question or volatile by-products of the alcoholic fermentation process itself. Most people are aware that there is no *definite* relationship between the intoxicating effects of certain wines and the amounts of alcohol which they contain, and the marked difference in the physiological effects of new whisky on one hand, and of well-matured spirit *of the same alcoholic strength* on the other, is a matter of common experience.

In the case of beer the soporific effect depends not a little on the hop and other extractives, and consequently there is no scientific justification for drawing any definite conclusions of a quantitative character as to the physiological effects of small doses of alcohol unless the beer used in the whole series of experiments had been of precisely the same character throughout, and even then the "personal equation" would introduce a further serious difficulty. Most beer-drinkers of middle age are well aware that the physiological effects of bitter beer on one hand, and of mild ale or lager (which are less heavily hopped) on the other, are not by any means the same, even for equal percentages of alcohol. The investigation of the effects of these various "secondary" constituents undoubtedly presents great experimental difficulties, but until their physiological significance is better understood there must always be an element of uncertainty in any conclusions arrived at in regard to the physiological effects of small doses of alcohol taken in the form of the usual alcoholic beverages.

A. CHASTON CHAPMAN.

London, November 15.

Atomic Structure.

THE arrangement of the non-nuclear electrons in the atom is being determined by work along two lines: first, from the Bohr-Sommerfeld theory of characteristic frequencies, and, secondly, from the Lewis-Langmuir or Born-Lande theory of the structure of molecules, supported by Prof. W. L. Bragg's work on atomic radii in crystals. It has been stated several times recently that the conclusions drawn from the two sources are mutually inconsistent, in that the first indicates that the electrons are revolving in planetary orbits, and the second that they are fixed in constant positions. The essential truth of the first theory is now beyond doubt; the second is extremely plausible. If they are really inconsistent the position would be intolerable.

But they are not really inconsistent. The Bohr-Sommerfeld theory does not make explicit use of the assumption that the electrons in their stable states are moving; it assumes only that in those states they have the energy, calculated by Hamiltonian (relativity) dynamics, which they would have if they were moving in certain orbits. It is not logically impossible to maintain that they have that energy and are yet at rest. Nor is it physically impossible if we accept Bohr's principle of "correspondence," which has been so astoundingly successful in explaining the Stark effect and in predicting the number of components in lines of the hydrogen and helium spectra. According to that principle, the intensity and polarisation of components can be predicted by the application of classical dynamics to certain assumed orbits, although it must be assumed at the same time that the electrons are *not* moving in those orbits. If intensity and polarisation can be predicted from orbits that are wholly fictitious, why not energy?

Of course, the adoption of Bohr's principle in this extreme form would sever the last connection between classical dynamics and the real structure of the atom. But we are surely now all convinced that we must abandon part of that connection. Is there any reason

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but mere conservatism that makes us hesitate to abandon all of it, and to admit that, even in respect of energy, a fixed electron can have the properties which classical dynamics attributes to a moving electron? Classical dynamics, it is clear, is only "statistical"; what are the principles of the elements of the statistical group is the main problem of the physics of the future. NORMAN R. CAMPBELL.

November 16.

The Testing of Balloon Fabrics.

ON p. 130 of the Report of the National Physical Laboratory for 1919 reference is made to the testing and experimental work carried out in connection with the manufacture of balloon fabrics for war purposes, and in connection with this we wish to place on record this company's work in the manufacture of materials, especially hydrogen-proof fabric, for lighter-than-air craft.

The North British Rubber Co., Ltd., first took up the manufacture of this material in 1908, and, realising that the problems involved in manufacture necessitated scientific control, as a preliminary installed in its laboratory an apparatus for measuring the permeability of rubber to hydrogen, and thereafter initiated research into the factors responsible for the deterioration of rubber under the influence of light.

When the Admiralty installed its test station at Manchester we were requested by the officer in charge to furnish drawings of the special type of hydrogen diffusion apparatus which had been designed at Castle Mills, and one of its staff received a course of instruction in the company's laboratories on the procedure to be followed in testing balloon fabric. At a later period of the war this department was taken over by the newly formed War Office Aircraft Fabrics Department, which installed an extended testing plant, and another member of that staff also received his training in this work in our aeronautical laboratories.

The Aeronautical Inspection Department was also indebted to the laboratory of the North British Rubber Co., Ltd., for the training of some of its scientific staff, and its testing equipment was in many respects also based on the results of this experience.

During the course of the war our output was steadily increased, and at the armistice we were manufacturing more than 35,000 yards of balloon fabric per week, every piece of which was tested in our aeronautical laboratories for weight, strength, and hydrogen leakage.

The investigation of the research laboratory into the action of light on rubber resulted, moreover, amongst other things, in a discovery which, without any increase in weight, permitted the production of a fabric of vastly enhanced durability specially suitable for use in the tropical theatre of the war.

Our reason for asking for the publication of this communication is only for the purpose of stating that at least one manufacturer was sufficiently well equipped, not only in the manufacture, but also in their scientific staff and laboratories, to carry on without outside help, and it is not intended to detract in any way from the very useful and great assistance which the National Physical Laboratory gave to Government Departments and others starting out in what was probably new ground to them.

W. A. WILLIAMS,
Works Manager.

The North British Rubber Co., Ltd., Castle
Mills, Edinburgh, November 12.

Luminosity by Attrition.

WITH reference to Sir Ray Lankester's suggestion in NATURE of November 4 that chemists should endeavour to ascertain the cause of the "empyreumatic" odour which accompanies the flashes of light produced by rubbing two quartz pebbles together, may I suggest also that the inquiry might be extended to include other substances which possess this property of triboluminescence?

The property is not confined to *crystallised* silica; it is displayed also by the amorphous varieties (opal, etc.) and by flint and chert.

Felspars possess the property in varying degrees; in general, it is more pronounced in the alkali felspars than in the lime-soda species. Fused albite displays the property.

Certain types of igneous rocks, both crystalline and glassy, behave in the same way. The property is most marked in the acid types; in the basic types (*e.g.* picrites, etc.) it is feeble or wanting.

Among the sedimentaries, sandstones, arkose, etc., and among the metamorphics, gneiss and some crystalline schists, display the property. The empyreumatic odour is a general accompaniment in the cases referred to above.

Saccharin and certain varieties of sugar possess the property in a moderate degree, and Dr. Lawson (Newcastle) has observed it in uranium nitrate when crystals of the salt are shaken up in a bottle.

I have investigated a large number of other substances (artificial glasses, rocks, and minerals); in the main, the results are negative.

Luminescence occurs between any pair of the "active" rock or mineral substances mentioned, and it would seem that the property is not dependent on crystallinity or wholly on chemical composition, but its relation to silica content (in silicates, etc.) is as yet obscure.

As regards the crystalline substances, the idea prevalent on the Continent is that during the process of crystallisation some of the outer electrons of the atom-system become detached, as it were, from the rest, but can recombine, with accompanying luminescence, under the stimulus of violent vibration. On the other hand, it may be a piezo-electric phenomenon; strain and deformation may induce positive and negative electrical charges on neighbouring particles, discharge being accompanied by luminescence. As the investigation is incomplete, further discussion would be out of place. A. BRAMMALL.

Imperial College of Science and Technology
(Royal School of Mines), South Kensington, S.W.7, November 13.

Spiranthes autumnalis.

IN NATURE of September 16, p. 79, I reported the occurrence of this orchis, new to Scotland, in Lower Strathspey. As I can find no record of the species growing on soil other than cretaceous, and as there is no lime in the soil where I found the plants, I suspect that I may have been deceived by the superficial resemblance between Spiranthes and *Goodyera repens*. The point, of course, might have been decided at once by lifting a root; but, being very unwilling to disturb rare plants, I refrained from doing so. I hope to return to the place next summer to verify the species; until then I must ask botanists to dismiss my note as *non avenue*. If it should prove that I have erred, I have done so in good company, for was not Sir Joseph Hooker deceived by the decussate, scale-like leaves of *Veronica cupressoides* into pronouncing that plant to be coniferous from specimens sent from New Zealand? HERBERT MAXWELL.

Monreith.

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